

ORIGINAL
(Red)

808 Main Ave. / Nitro, W. Va. 25143 / (304) 755-8228

ACKENHEIL & ASSOCIATES

CONSULTING ENGINEERS

West Virginia, Inc.

December 1, 1979

Monsanto Industrial Chemicals
Nitro, West Virginia
25143

Attention: (b) (4)

Gentlemen:

Subject: Soil Testing Services Report
Dated November 15, 1979
Monsanto Nitro Plant Landfill
Nitro, West Virginia
Nitro Project No. 79169N

In accordance with your request we present for your information additional data and conclusions concerning permeability tests presented in the subject report.

I. DATA

- A. The three (3) soil permeability test samples were compacted to 80% of the maximum dry density at the maximum water content as determined by ASTM D 1557. Modified Proctor compaction curves were presented on Dwg. Nos. 79169N-9 through 12.
- B. A comparison of plasticity test results and the soil permeability test sample water contents are as follows:

	Soil Type	Soil Moisture Content	Liquid Limit	Plastic Limit	Plastic Index
USED FOR CLAY CAP	Red Brown Poca Clay	18	33	18	15
	Cross Lanes Red Brown Clay	22	32	17	15
	Present Landfill	26	27	18	9

I. DATA (Cont'd)

- C. Hydraulic Head and Gradient: The hydraulic head and gradients used in the performance of the constant head permeability tests are listed below. The hydraulic gradient is computed as the hydraulic head divided by the test specimen length.

<u>Soil Type</u>	<u>Hydraulic Head (ft.) H</u>	<u>Hydraulic Gradient H/L</u>
Red Brown Poca Clay	18.5	48.4
Cross Lanes Red Brown Clay	18.5	48.4
Present Landfill	21.25	55.7

- D. Degree of Saturation: The degree of saturation of each permeability test sample was approximated using the soil moisture content and by assuming a specific gravity of soil solids of $G=2.7$. The results of these calculations are as follows:

<u>Soil Type</u>	<u>Degree of Saturation (Percent) Laboratory</u>
Red Brown Poca Clay	84
Cross Lanes Red Brown Clay	91
Present Landfill	91

In general the field density test results indicated a lower degree of saturation in the field than the conditions assumed in the laboratory.

II. CONCLUSIONS

The following conclusions represent our opinion and interpretation of the data contained in this report and generally accepted soil mechanics theory.

- A. Plasticity: The plasticity of a given soil is related to its permeability. In comparing two soils of similar grain size distribution, the soil with the higher plasticity will generally be the more impervious of the two.
- B. Percent Compaction: Our compaction test results on fill and natural soil at the subject landfill indicated a degree of compaction generally above 80% and in several cases above 90%. These test results are included in our Letter Report dated November 15, 1979. The permeability of a given soil will decrease with an increase in the degree of compaction. The amount of this increase will probably vary considerably with each soil type.

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II. CONCLUSIONS (Cont'd)

- C. Hydraulic Gradient: The permeability of clayey soils is related to the hydraulic gradient applied to the soil. If the hydraulic gradient is lowered the permeability of a clay soil generally decreases. In fact, at very low gradients, clay soils become virtually impermeable. In a typical field example, a 2 ft. thick liner below 10 ft. of water would have a hydraulic gradient of 5. This is approximately 1/10 of the hydraulic gradient used in the laboratory for the performance of the permeability test.
- D. Degree of Saturation: The degree of saturation of a given field sample or test specimen is related to the permeability of the specimen. In general soils compacted to the same density will probably have lower permeabilities at low degrees of saturation than samples with high degrees of saturation. This relationship would probably not be true with very low degrees of saturations. As indicated in Item 4 of the Data Obtained, the degrees of saturation for the samples tested in the laboratory were higher than indicated by our field compaction tests.
- E. Overall Permeability: The permeability of a layer of clay soil or a clay liner ~~fill~~ could be greatly increased if cracks, holes or other discontinuities exist within the soil layer. These discontinuities obviously would not be revealed with a permeability test.
- F. Testing: Due to the variability of soil types additional laboratory and field soil tests should be performed to more thoroughly substantiate conclusions presented in this Letter Report.

If you have any questions concerning this Letter Report, please contact us.

We appreciate the opportunity to serve you.

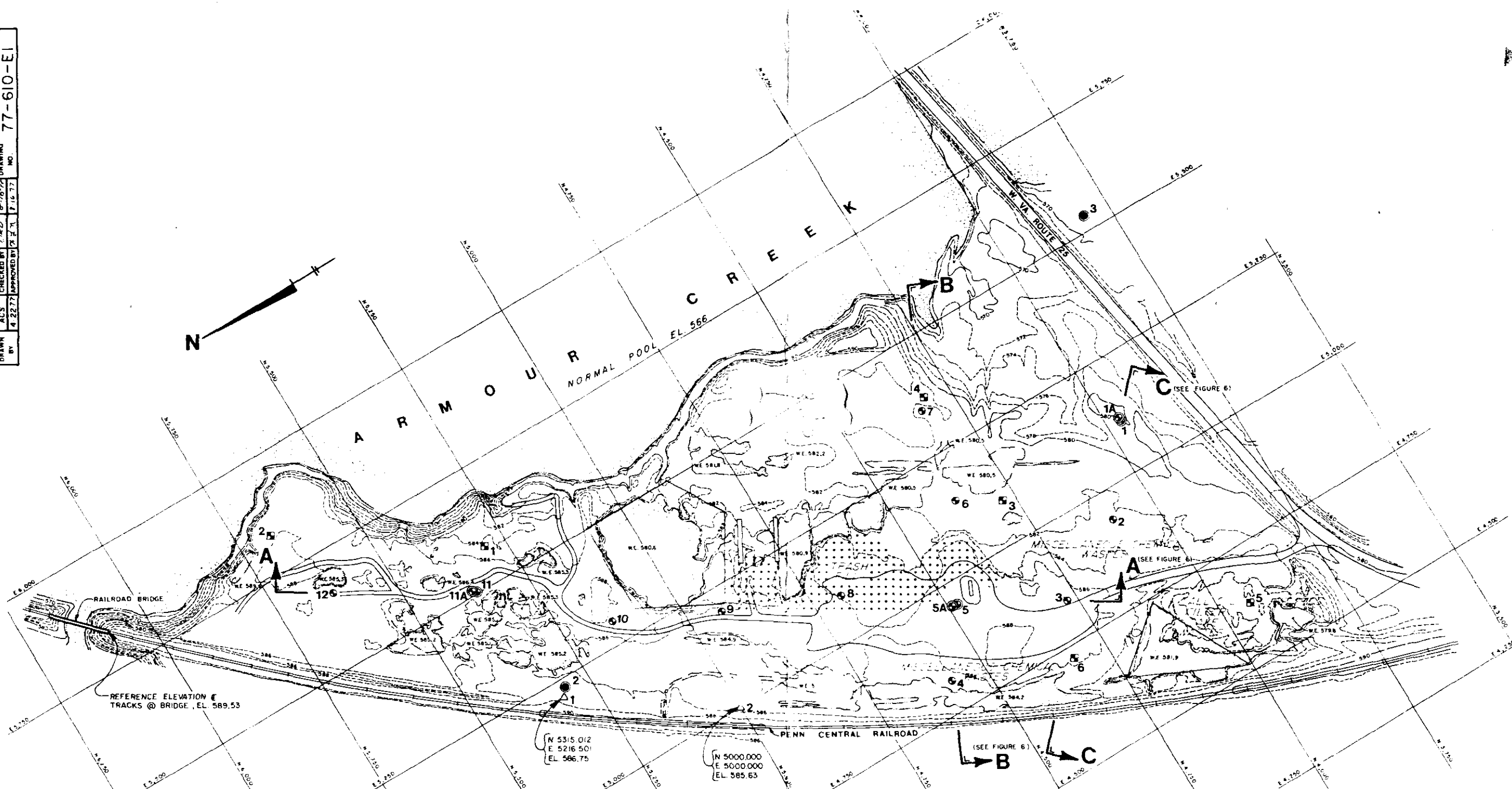
Very truly yours,

ACKINHEIL & ASSOCIATES WEST VIRGINIA, INC.

(b) (4)

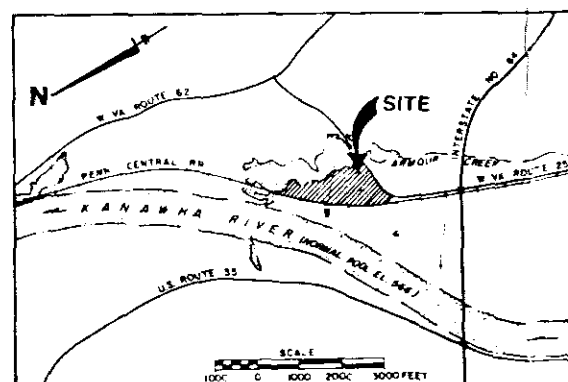


CAL/bw



LEGEND

- 8⁶ BORING LOCATION - DRILLED UNDER D'APPOLONIA SUPERVISION
- 5⁶ LOCATION OF BORING IN WHICH STANDPIPE PIEZOMETER WAS INSTALLED AT COMPLETION
- 4⁵ TEST PIT LOCATION
- WE 584.4 LOCATION AND ELEVATION OF PONDED WATER
- 3⁶ LOCATION OF BORING IN WHICH PIEZOMETER WAS INSTALLED FOR PREVIOUS INVESTIGATION - DRILLED UNDER MONSANTO SUPERVISION
- 1^Δ ROD NO. 1 (BENCH MARK)



VICINITY MAP

SITE ACREAGES
 (EXCLUSIVE OF STEEP BANKS)

DESCRIPTION	FLOOD RECURRENT INTERVAL	ACREAGE	% TOTAL
TOTAL		34	100
FLOODED AREA BELOW EL. 573	10 YEARS	1.2	3.6
FLOODED AREA BELOW EL. 576	20 YEARS	2.6	7.8
FLOODED AREA BELOW EL. 580	50 YEARS	4.3	12.6
FLOODED AREA BELOW EL. 584	100 YEARS	19.4	56.9
USABLE AREA AT EL. 586 WITHIN PROPOSED DIKES	100 YEARS +	29.0	85.3

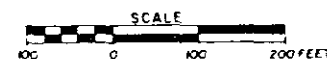


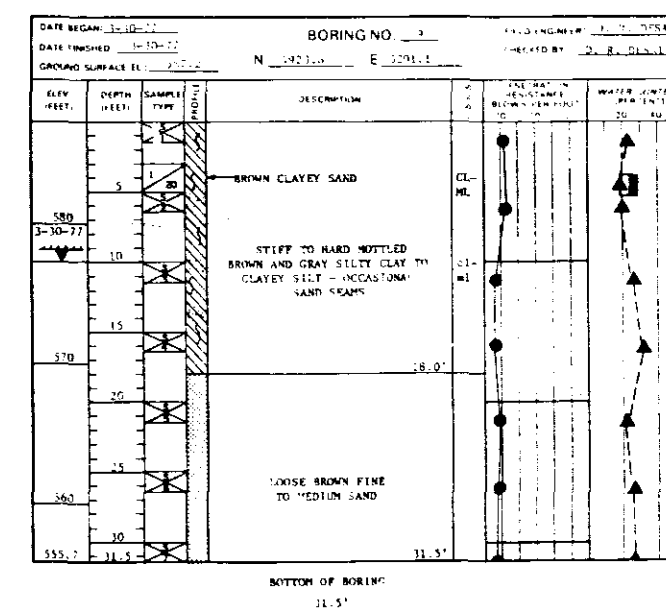
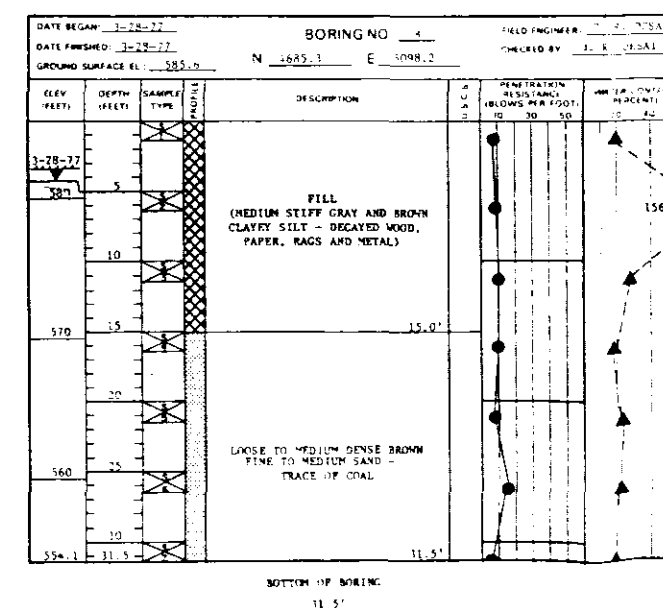
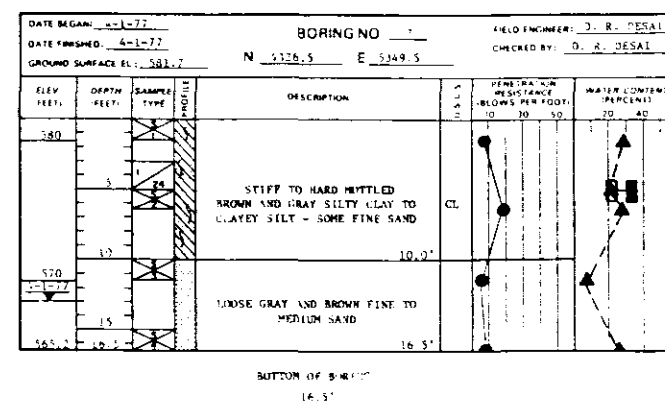
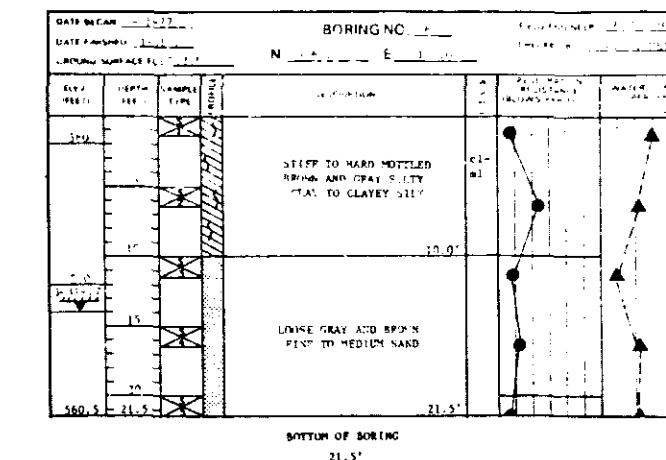
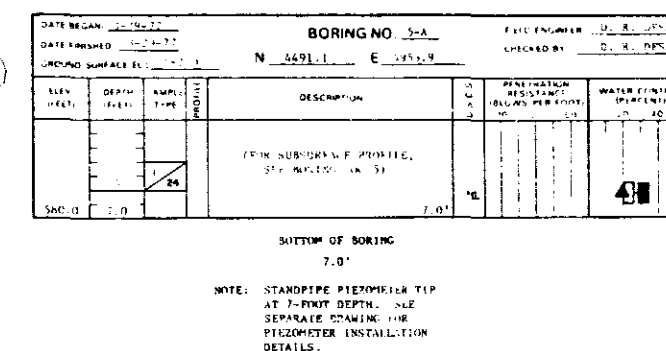
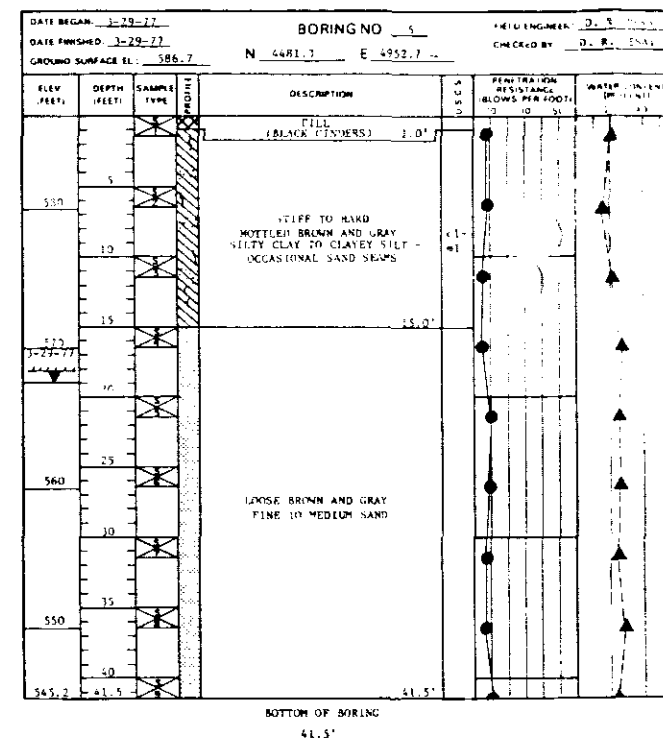
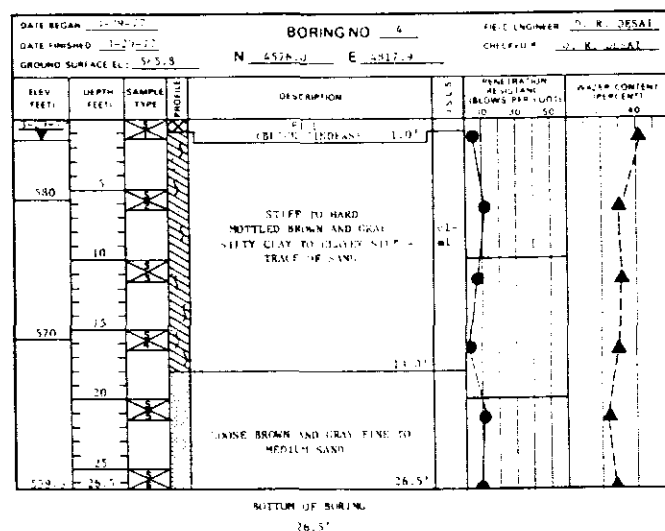
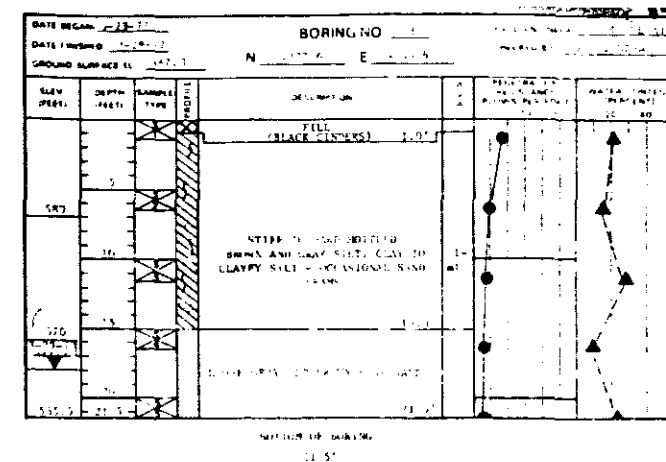
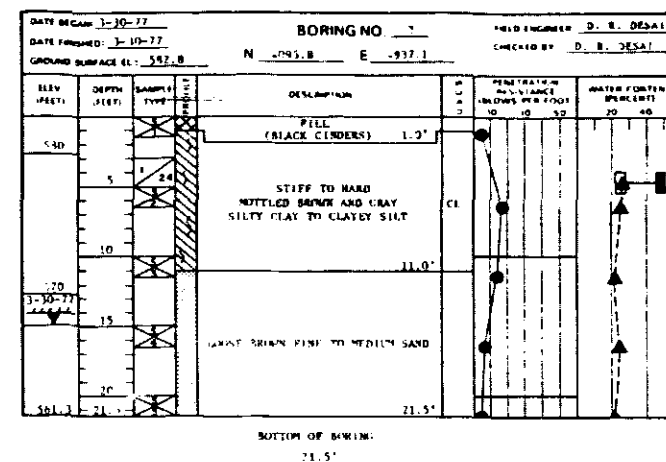
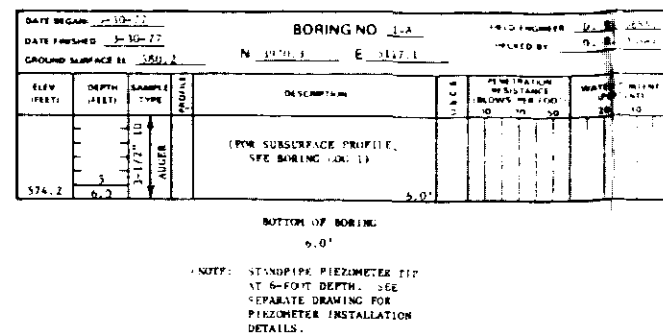
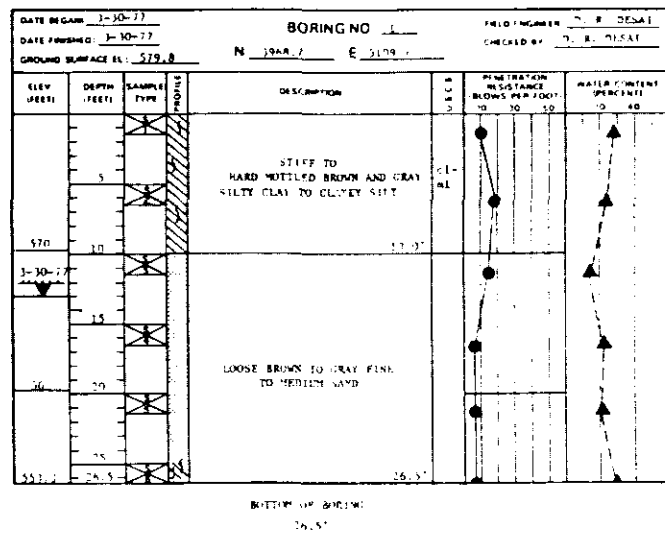
FIGURE 2

PHYSIOGRAPHIC PLAN AND LOCATIONS OF BORINGS AND TEST PITS
 CHEMICAL WASTE LANDFILL INVESTIGATION
 POCATALICO TOWNSHIP
 PUTNAM COUNTY, WEST VIRGINIA

PREPARED FOR

MONSANTO COMPANY
 NITRO, WEST VIRGINIA

D'APPOLONIA



THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED. SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE BORING LOCATIONS. ALSO, THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE BORING LOCATIONS.

THE DEPTH AND THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THE SECTIONS WERE GENERALIZED FROM AND INTERPOLATED BETWEEN THE TEST BORINGS. INFORMATION ON ACTUAL SUBSURFACE CONDITIONS EXISTS ONLY AT THE LOCATION OF THE TEST BORINGS AND IT IS POSSIBLE THAT SUBSURFACE CONDITIONS BETWEEN THE TEST BORINGS MAY VARY FROM THOSE INDICATED.

- NOTE:
1. FOR PLAN AND LOCATION OF BORINGS, SEE FIGURE 2.
 2. FOR GENERAL NOTES AND LEGEND, SEE FIGURE 4.

FIGURE 3

BORING LOGS 1 THROUGH 9
CHEMICAL WASTE LANDFILL INVESTIGATION
POCATALICO TOWNSHIP
PUTNAM COUNTY, WEST VIRGINIA

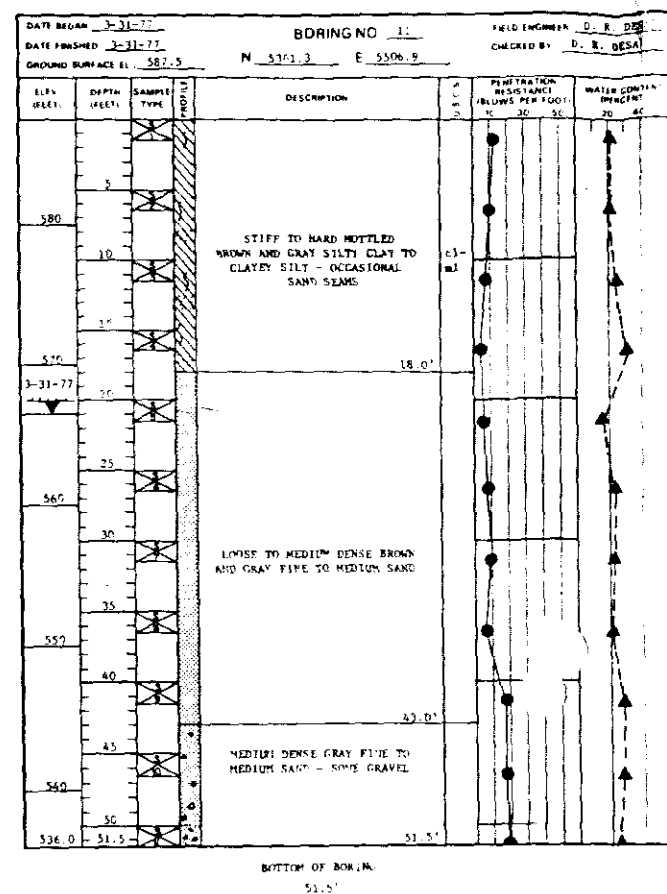
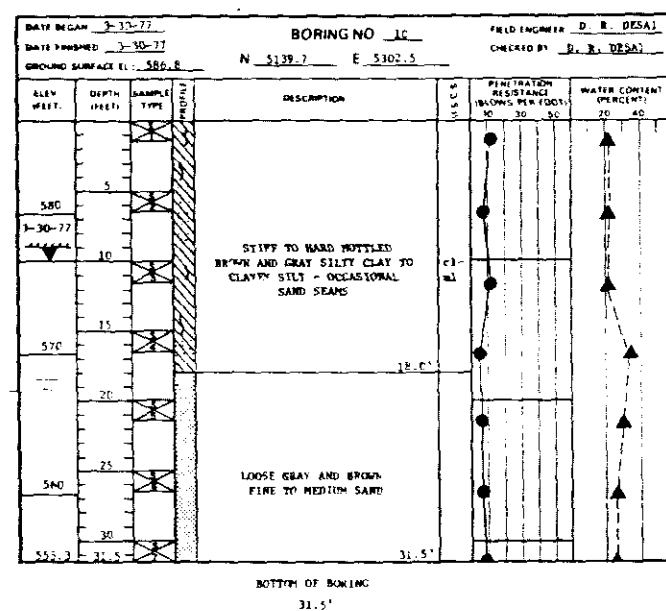
PREPARED FOR

MONSANTO COMPANY
NITRO, WEST VIRGINIA

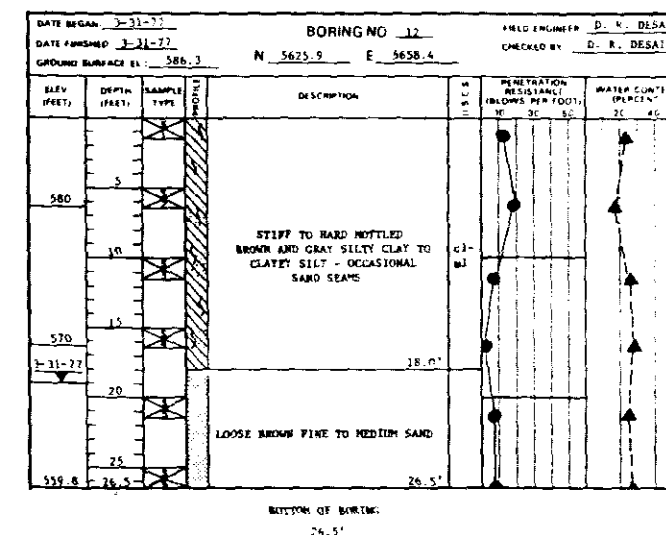
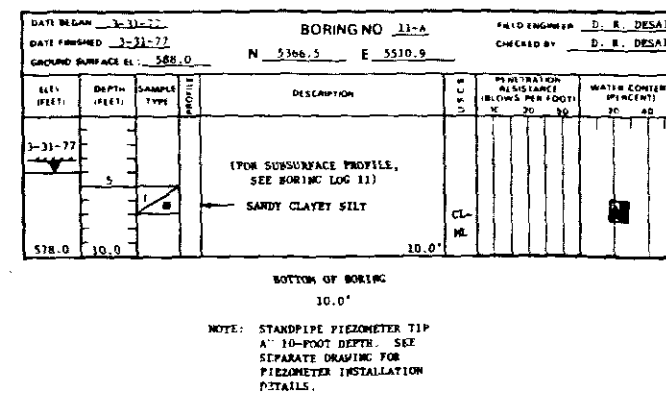
D'APPOLONIA

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DRAWN BY TRS CHECKED BY GED 8/6/77 DRAWING NO. 77-610-E4



NOTE: STANDPIPE PIEZOMETER TIP AT 49-FOOT DEPTH. SEE SEPARATE DRAWING FOR PIEZOMETER INSTALLATION DETAILS.



- LEGEND**
- 2" O.D. SPLIT BARREL SAMPLE NUMBER
 - 75/0.5 PENETRATION REFUSAL RESISTANCE AND FRACTIONAL INCREMENT DRIVEN IN FEET
 - 3-31-77 GROUND WATER LEVEL AND DATE
 - U.S.C.S. UNIFIED SOIL CLASSIFICATION SYSTEM (CAPITAL LETTERS INDICATE LAB TEST CLASSIFICATION, LOWER CASE LETTERS INDICATE VISUAL FIELD CLASSIFICATION)
 - SAMPLE NUMBER
 - 3" UNDISTURBED SAMPLE (SHELBY TUBE) RECOVERY INCHES
 - PLASTIC LIMIT (PL)
 - ATTERBERG LIMITS
 - LIQUID LIMIT (LL)
 - LOCATION OF UNDISTURBED SHELBY TUBE SAMPLE AS SHOWN ON SECTIONS
 - LOCATION OF STANDPIPE PIEZOMETER AS SHOWN ON SECTIONS

Gravel
Sand
Silt
Clay
Fill

CONSISTENCY OF COHESIVE SOILS	
CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH TONS PER SQUARE FOOT
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	MORE THAN 4.0

GENERAL NOTES

DENSITY OF GRANULAR SOILS	
DESIGNATION	BLOWS PER FOOT
VERY LOOSE	0-4
LOOSE	5-10
MEDIUM DENSE	11-30
DENSE	31-50
VERY DENSE	OVER 50

STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2 INCH O.D. SPLIT BARREL SAMPLER 12 INCHES USING A 140 POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER WAS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6 INCH INTERVAL. THE RESISTANCE TO PENETRATION IS INDICATED ON THE DRAWING AS BLOWS PER FOOT.

THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED. SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE BORING LOCATIONS. ALSO THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE BORING LOCATIONS.

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NOTE:
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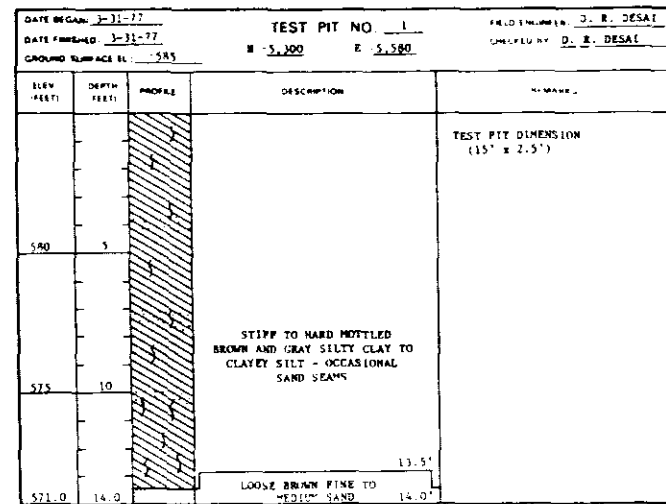
FIGURE 4
BORING LOGS 10 THROUGH 12
& GENERAL NOTES AND LEGEND
CHEMICAL WASTE LANDFILL INVESTIGATION
POCOTALICO TOWNSHIP
PUTNAM COUNTY, WEST VIRGINIA

PREPARED FOR

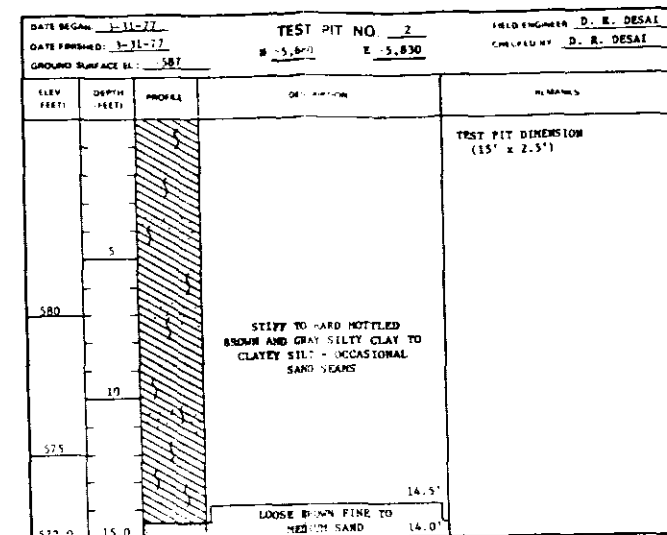
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NITRO, WEST VIRGINIA

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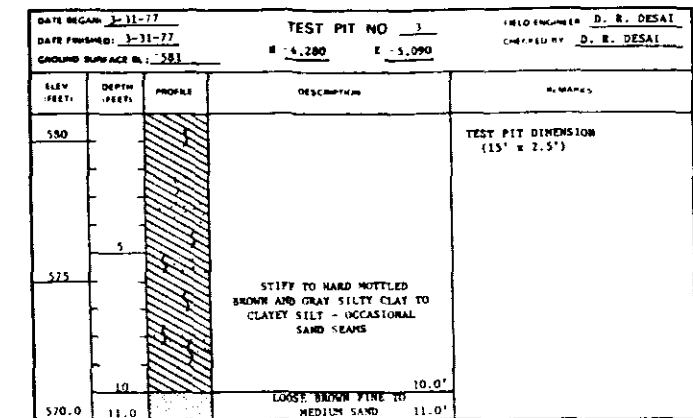
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DATE: 3-31-77
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DATE: 3-31-77



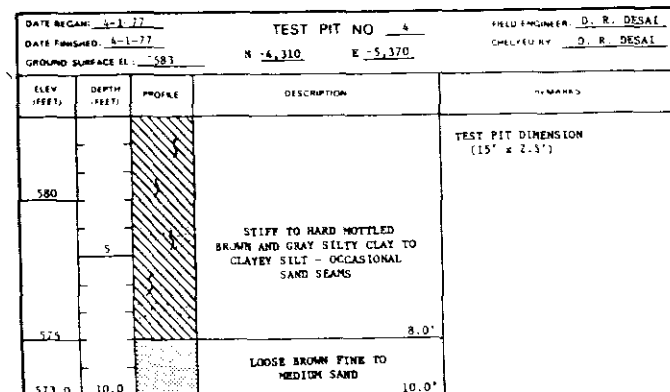
- NOTES:
1. SOIL SAMPLE COLLECTED FROM FROM 2 TO 8 FEET OF DEPTH.
 2. RAINFALL ON 3-29-77.



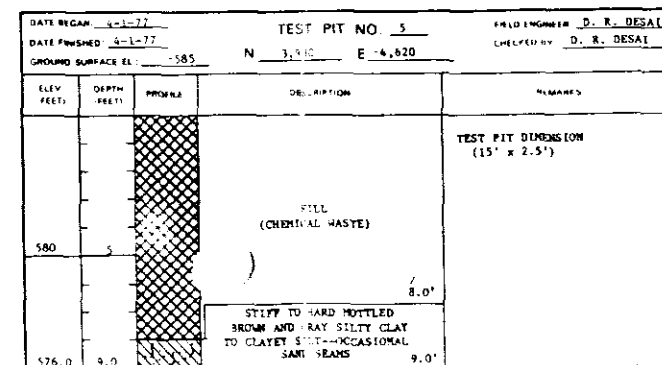
- NOTES:
1. NOIZING WATER AT 75-FOOT DEPTH.
 2. SOIL SAMPLE COLLECTED FROM 2 TO 8 FEET OF DEPTH.
 3. RAINFALL ON 3-29-77.



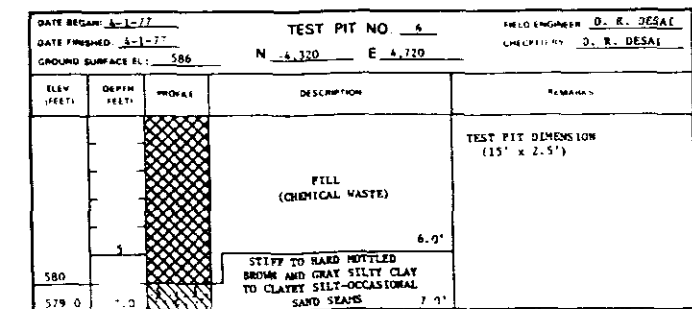
NOTE: RAINFALL ON 3-29-77.



NOTE: RAINFALL ON 3-29-77.



NOTE: RAINFALL ON 3-29-77.



NOTE: RAINFALL ON 3-29-77.

THE TEST PIT LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED. SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE TEST PIT LOCATIONS. ALSO THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE TEST PIT LOCATIONS.

NOTE:

1. FOR PLAN AND LOCATION OF TEST PITS, SEE FIGURE 2.
2. FOR GENERAL NOTES AND LEGEND, SEE FIGURE 4.

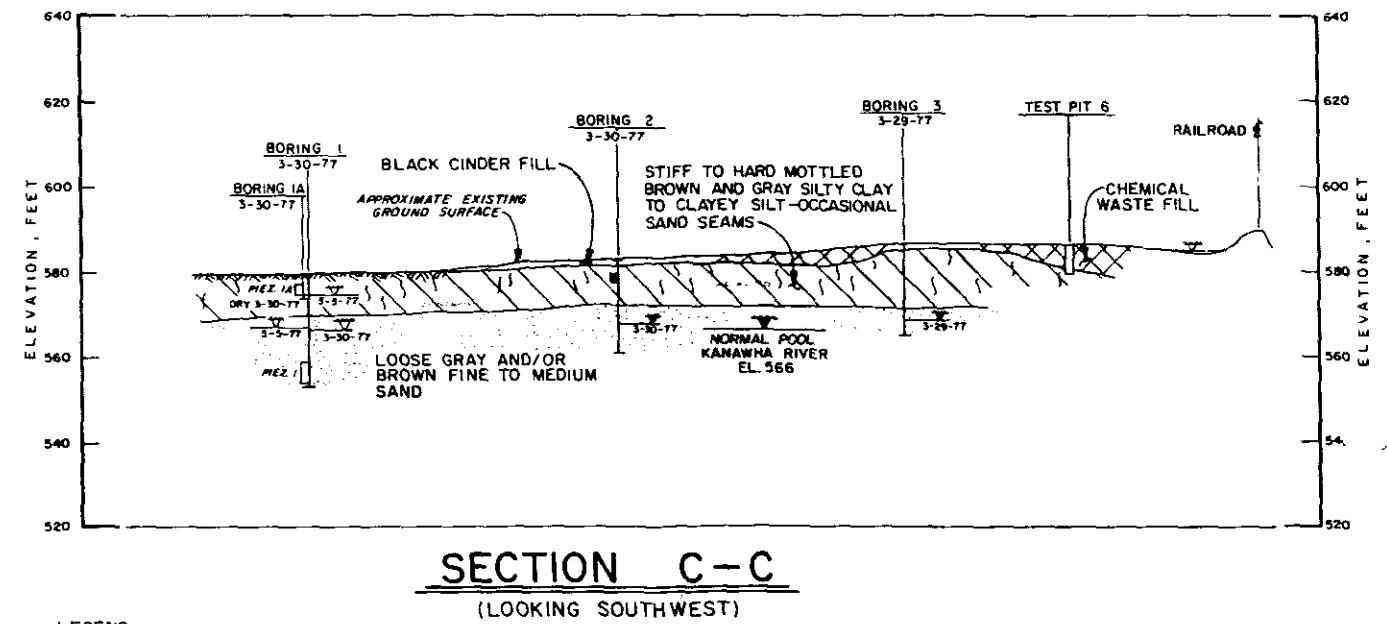
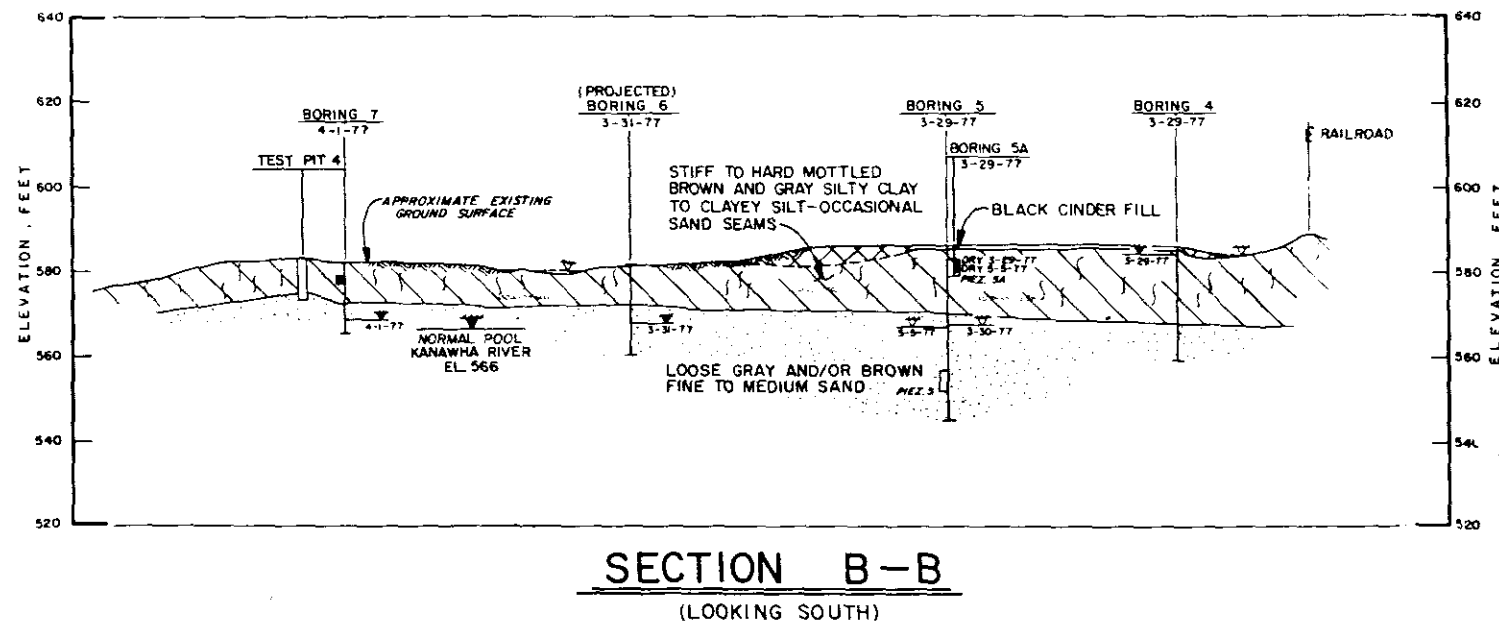
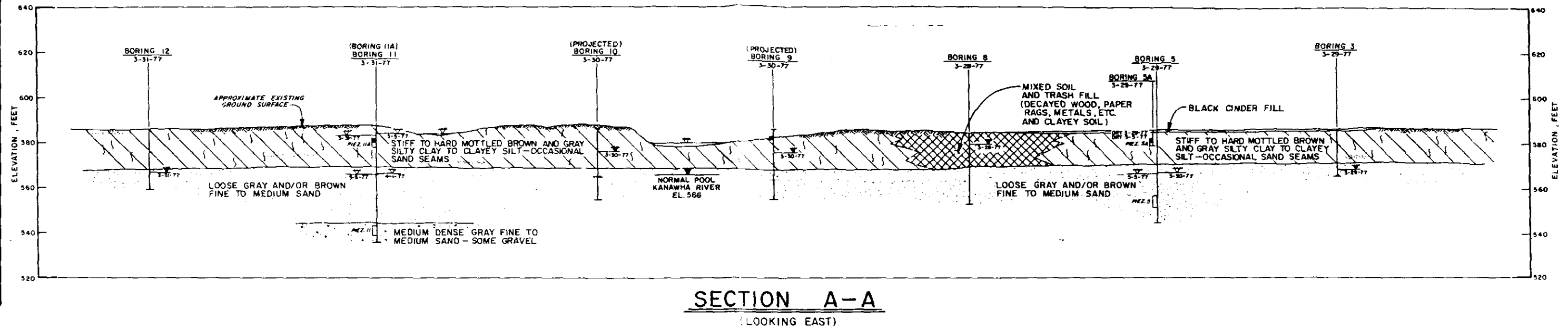
FIGURE 5

TEST PIT LOGS I THROUGH 6
CHEMICAL WASTE LANDFILL INVESTIGATION
POCATALICO TOWNSHIP
PUTNAM COUNTY, WEST VIRGINIA

PREPARED FOR

MONSANTO COMPANY
NITRO, WEST VIRGINIA

D'APPOLONIA



NOTES:

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NOTES:

1. FOR PLAN AND LOCATION OF BORINGS, TEST PITS AND SECTIONS SEE FIGURE 2.
2. FOR GENERAL NOTES AND LEGEND SEE FIGURE 4.
3. FOR DETAILED DESCRIPTION OF BORINGS AND TEST PITS SEE FIGURES 3, 4 AND 5.

LEGEND:

- SHELBY TUBE SAMPLE
- PIEZOMETER SENSING ZONE
- WATER LEVEL IN BORING UPON COMPLETION OF DRILLING
- DATE OF OBSERVATION
- WATER LEVEL IN PIEZOMETER
- DATE OF OBSERVATION

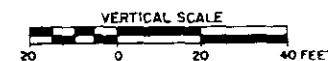
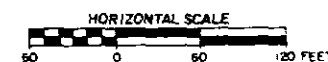


FIGURE 6

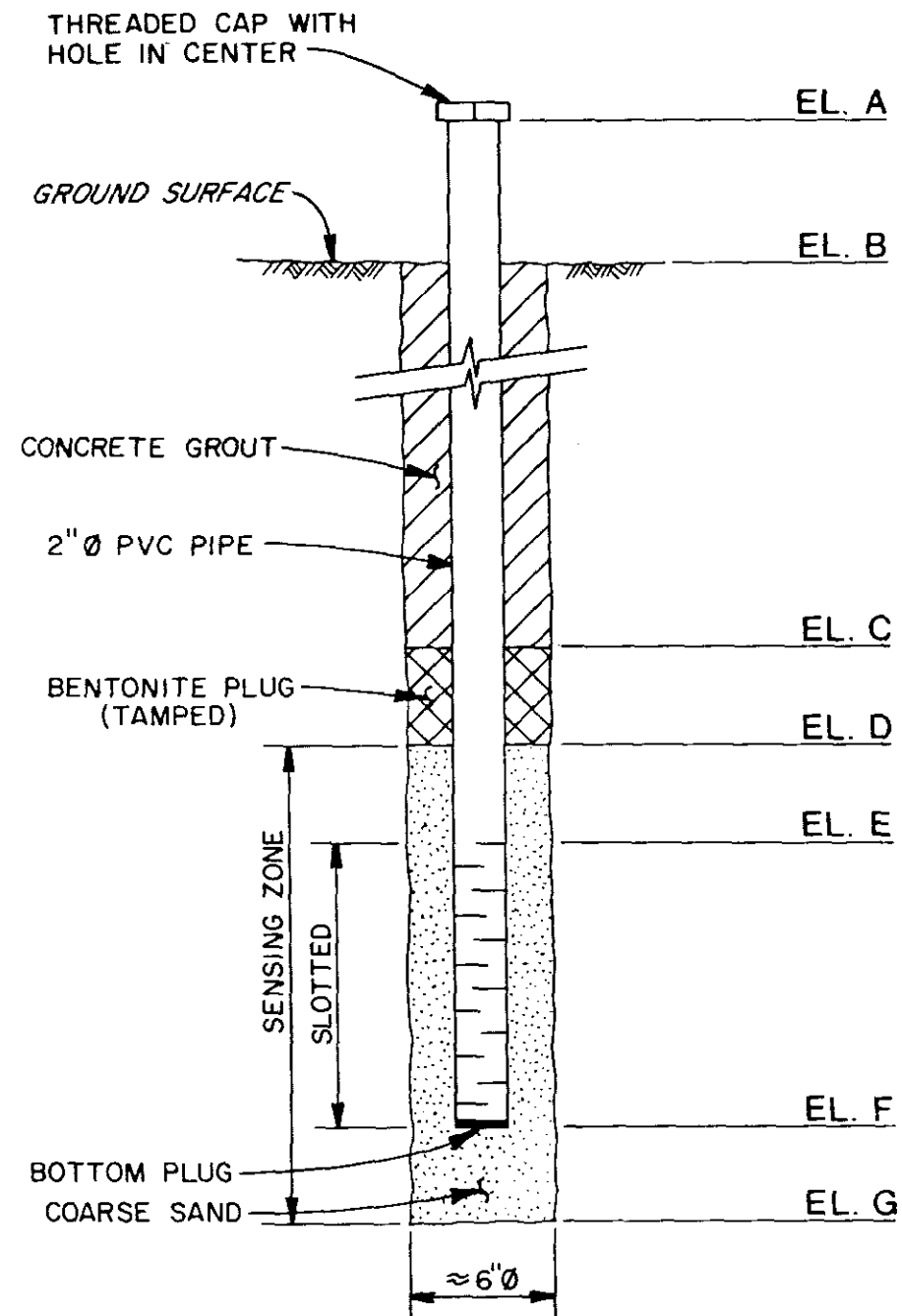
SUBSURFACE PROFILES-
 SECTIONS A-A, B-B AND C-C
 CHEMICAL WASTE LANDFILL INVESTIGATION
 POCATALICO TOWNSHIP
 PUTNAM COUNTY, WEST VIRGINIA

PREPARED FOR

MONSANTO COMPANY
 NITRO, WEST VIRGINIA

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DRAWN BY J.G.S. CHECKED BY J.D.L. 8/16/77 DRAWING NUMBER 77-610-B1
BY 4-21-77 APPROVED BY J.A.N. 8/16/77



TYPICAL STANDPIPE PIEZOMETER INSTALLATION

N.T.S.

PIEZOMETER BORING NO.	DATE INSTALLED	ELEVATIONS						
		A	B	C	D	E	F	G
I	3-30-77	582.8	579.8	562.8	560.8	558.8	553.8	553.3
IA	3-30-77	583.7	580.2	579.2	578.2	577.2	574.2	574.2
5	3-29-77	589.7	586.7	560.7	558.7	556.7	551.7	545.2
5A	3-29-77	590.5	587.0	586.0	584.0	583.0	580.0	580.0
II	3-31-77	590.5	587.5	547.0	545.0	543.0	538.5	536.0
IIA	3-31-77	591.5	588.0	584.0	582.0	581.0	578.0	578.0

NOTES:

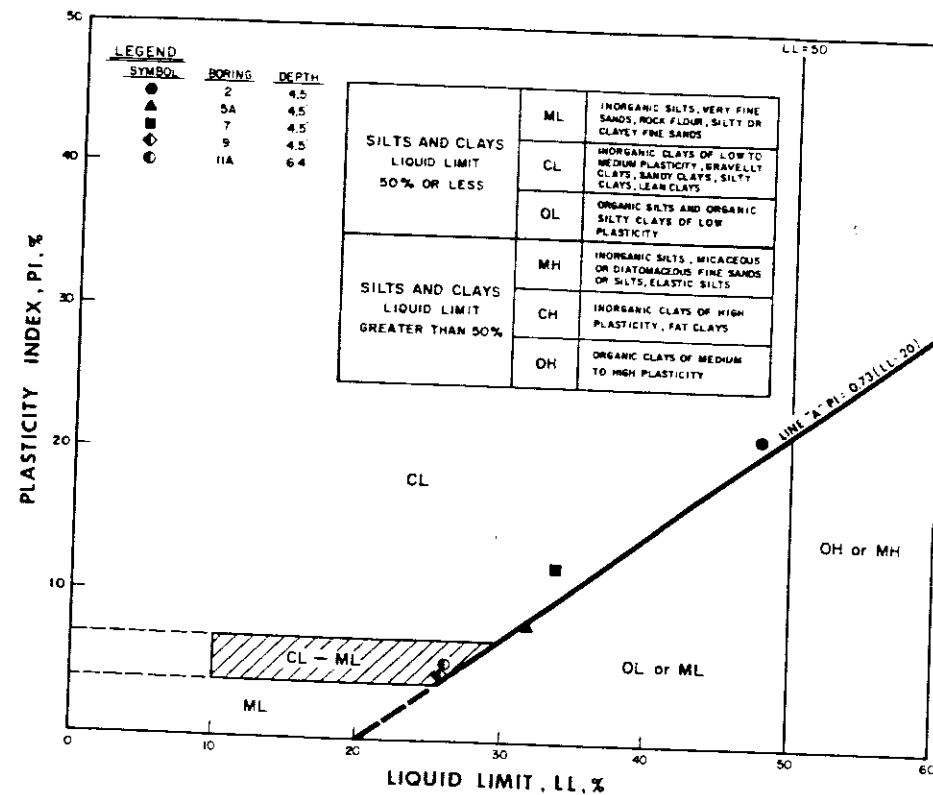
1. FOR PLAN AND LOCATION OF BORINGS, SEE FIGURE 2.
2. FOR SUBSURFACE PROFILE, SEE INDIVIDUAL BORING LOGS.

FIGURE 7
DETAILS OF PIEZOMETER INSTALLATIONS
CHEMICAL WASTE LANDFILL INVESTIGATION
POCATALICO TOWNSHIP
PUTNAM COUNTY, WEST VIRGINIA
PREPARED FOR

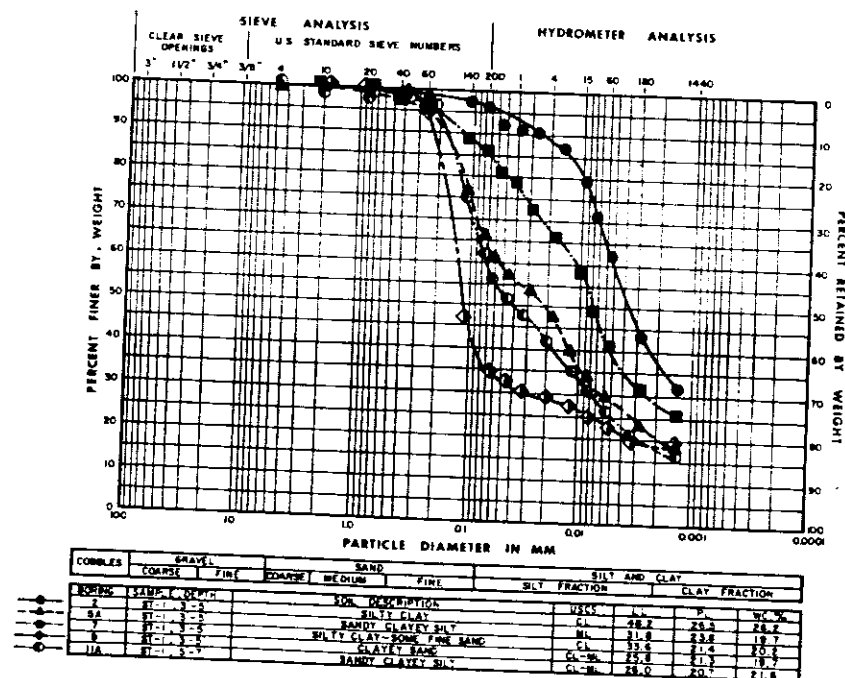
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NITRO, WEST VIRGINIA

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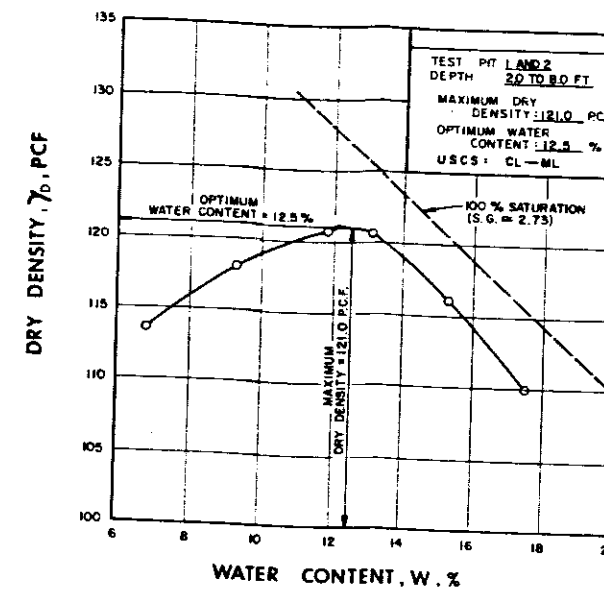
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PLASTICITY CHART



GRAIN SIZE DISTRIBUTIONS



METHOD	MATERIAL SIZE	MOLD SIZE	BLOWS	ASTM DESIGNATION	MODIFIED
A	ALL PASSING #4	4" DIA	25	ASTM D 1557	A
B	ALL PASSING #4	6" DIA	25	ASTM D 1557	A
C	ALL PASSING 3/4"	6" DIA	25	ASTM D 1557	A
D	ALL PASSING 3/4"	6" DIA	56	ASTM D 1557	A

COMPACTION TEST RESULTS

NOTES:

- FOR PLAN AND LOCATION OF BORINGS AND TEST PITS, SEE FIGURE 2.
- FOR DETAILED DESCRIPTION OF BORINGS AND TEST PITS, SEE FIGURES 3, 4 AND 5.

FIGURE 8

LABORATORY TEST RESULTS
SHEET 1 OF 2
CHEMICAL WASTE LANDFILL INVESTIGATION
POCOTALICO TOWNSHIP
PUTNAM COUNTY, WEST VIRGINIA

PREPARED FOR

MONSANTO COMPANY
NITRO, WEST VIRGINIA

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